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The western false hemlock looper in British Columbia 1942-1984

J.W.E. Harris, A.F. Dawson and R.G. Brown

Information Report BC-X-269
Pacific Forestry Centre

86-0602/

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J.W.E. Harris

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Canadian Forestry Service
Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C.
V8Z 1M5

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ISSN 0705-3274
ISBN 0-662-14095-8
Cat. No. Fo46-17/269E

Abstract

The Forest Insect and Disease Survey annually detects, monitors, and appraises defoliator infestations by measuring larval populations at a network of ground sampling stations and by observing defoliation from light aircraft. This report summarizes such observations on outbreaks of the western false hemlock looper, *Nepytia freemani*, an important defoliator of Douglas-fir stands in the dry belt areas of southern British Columbia (B.C.).

Populations of the western false hemlock looper have periodically increased to outbreak levels causing localized defoliation and tree mortality. Outbreaks have occurred primarily in the dry subzone of the Interior Douglas-fir Biogeoclimatic Zone, but damage also has been recorded in one instance in the Interior Cedar-Hemlock Zone. Four outbreaks have occurred in the southern Interior since 1947, with visible defoliation lasting from 2 to 4 years over major drainages, though often at different sites in the same drainage in different years. Tree mortality can result from one year of severe defoliation.

In each year preceding that when visible defoliation was first recorded in an area, average larval populations ranged between 0 and 16 per sample; in the year of first recorded defoliation populations rose to between 3 and 46, and a year or two later peaked at between 37 and 91 larvae per sample.

Résumé

Le Relevé des insectes et des maladies des arbres permet de déceler, de surveiller et d'évaluer annuellement les infestations de défoliateurs grâce au dénombrement des populations de larves par le réseau de stations d'échantillonnage au sol et à l'observation de la défoliation à l'aide d'aéronefs légers. Ce rapport résume les observations concernant les infestations de l'arpenteuse de Freeman (*Nepytia freemani*), qui est un important défoliateur des peuplements de douglas taxifolié dans les zones de ceinture sèches du sud de la Colombie-Britannique.

Les populations de l'arpenteuse de Freeman ont périodiquement causé des infestations qui ont entraîné des défoliations locales avec mortalité des arbres. La sous-zone sèche de la zone biogéoclimatique intérieure peuplée de douglas taxifolié a été la plus touchée, mais un cas d'infestation a aussi été signalé dans la zone intérieure peuplée de cèdre et de pruche. Depuis 1947, quatre infestations se sont produites dans le sud de la zone intérieure; la defoliation visible a duré deux à quatre ans dans les principaux bassins versants, mais souvent à différents endroits dans le même bassin selon les années. Une seule année de défoliation sévère peut entraîner la mortalité.

Au cours de l'année précédant les premières défoliations visibles, le nombre de larves variait en moyenne entre 0 et 16 par échantillon; l'année de la première défoliation, ce nombre était de 3 à 46, et 1 ou 2 ans après il atteignait le maximum, soit 37 à 91 larves par échantillon.

Introduction

The first reported collection of the western false hemlock looper, *Nepytia freemani* Munroe (Lepidoptera: Geometridae), in British Columbia (B.C.) was near Chase in 1942 (Munroe 1963), and the first report of visible damage in B.C. was in 1947 at Radium and Columbia Lake. Since then, three other infestations have occurred, mainly in the dry belt areas of the Province. Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, is the preferred host, but this looper may feed on most other conifers. Pure stands of immature Douglas-fir have suffered the most damage, but mixed stands have also been attacked. Top-kill and tree mortality have occurred where feeding has been severe for one or more years, especially in stands on dry rocky sites, but trees have recovered even when total defoliation has been up to 90% in one year.

This looper is potentially a serious pest because it is a wasteful feeder; the larvae eat only part of a needle before they move to another. Young larvae feed on the new foliage of upper crowns, progressing to the older foliage and lower crown as they mature. The partially consumed needles dry out and discolor and by mid-summer trees take on a reddish-brown appearance. Pupation occurs in late July and August and adults then emerge and mate from August to October. Females lay eggs in small groups, usually on the underside of the host needles in the fall. The eggs then overwinter and hatch the following spring.

Infestations generally have occurred in the dry subzone of the Interior Douglas-fir Biogeoclimatic Zone (U.B.C. Faculty of Forestry 1983), but localized damage and high populations also have occurred in portions of the Interior Cedar-Hemlock Zone. Outbreaks have occurred in the North Thompson River, Shuswap Lake, and North Okanagan areas as has the Douglas-fir tussock moth (*Orgyia pseudotsugata* (McDunnough)), another defoliator of Douglas-fir in dry belt conditions (Harris *et al.* 1985). Unlike *Orgyia*, however it has not occurred in the South Okanagan or Similkameen areas but has caused damage in the East Kootenay.

Defoliators and the damage they cause are monitored annually throughout B.C. by staff of the Forest Insect and Disease Survey (FIDS), Canadian Forestry Service. Population records taken prior to 1949 were largely subjective estimates based on observations made without a particular sampling plan. However, since 1949 defoliator population levels were estimated by FIDS staff at a ground network of permanent sampling stations selected at sites representative of the surrounding stands (Harris 1976). Insect counts from sampling stations were combined, averaged, and plotted to show the rise and fall of populations over time. Observations of tree defoliation and mortality have continued to the present, with increased precision, as more use has been made of aerial surveys for detecting and appraising damage (Harris and Dawson 1979).

This report, patterned after similar reports of three other important forest defoliators (Harris *et al.* 1982; Harris *et al.* 1984; and Harris *et al.* 1985), describes the history of western false hemlock looper infestations in B.C. as recorded by FIDS, summarizing tree damage since 1947 and larval populations since 1949. The average numbers of larvae in samples and the percentage of positive samples were calculated for four geographic areas where infestations had occurred, so that population changes could be readily seen. Population levels leading into an infestation period were then examined to serve as a warning threshold of impending outbreaks.

Methods

Information on the western false hemlock looper in British Columbia was obtained from various published and unpublished records. Quantitative larval data for the period 1949-1984 were retrieved from the FIDS computer data file (Harris 1976). The most important literature sources were the FIDS annual regional and national (Canadian Forestry Service 1937-1984) reports which summarize forest pest conditions in B.C.[1]

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[1] a. "Annual District Reports, Forest Insect and Disease Survey, British Columbia 1920-1978" and "Forest Insect and Disease Conditions in British Columbia 1979-1984" (an annual file or internal report by Forest Region). Request by geographic area of interest and year. Limited numbers of copies of some years available for loan. By Canadian Forestry Service, Pacific Forestry Centre, Victoria, B.C.

b. "Annual Report of the Forest Insect and Disease Survey" (Canada-wide annually since 1937), Canadian Forestry Service, Ottawa. Request by year.

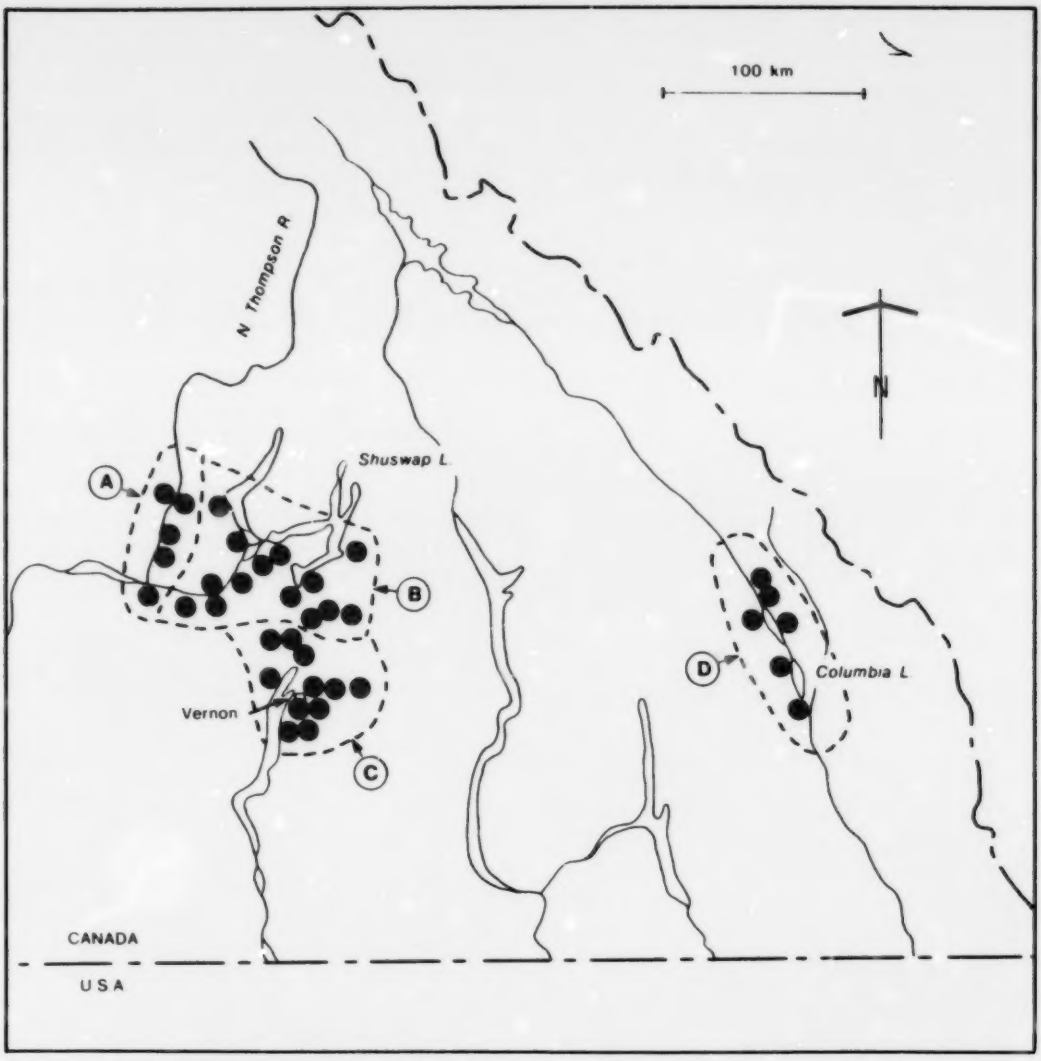

Fig. 1. Western false hemlock looper Forest Insect and Disease Survey permanent sampling stations (●) in the southern interior of British Columbia from 1949-1984 for four major study areas. Samples were combined to determine average numbers of larvae per sample and the percentage of positive samples in each area: (A) North Thompson, (B) Shuswap, (C) Vernon, (D) Columbia.

Numbers of western false hemlock looper larvae on Douglas-fir were determined annually from records collected by FIDS from 1949-1984 at 36 permanent sampling stations (Fig. 1), using the 3-tree beating method (Harris 1976). In this method, a 2.7-m pole was used to beat larvae from three trees at each station onto a 2.1-m × 2.7-m sheet spread beneath each tree on which the number of dislodged larvae were counted. The average number of larvae per sample and the percentage of samples containing larvae were then calculated for sampling stations within four geographic study areas (Fig. 1, A-D) in which infestations had occurred between 1949-1984. These areas were major drainages selected on the basis of the historical and geographical pattern of

western false hemlock looper outbreaks. The population estimates were graphed by year for each study area to show population trends. The study areas were:

North Thompson (Area A) — North Thompson River from Kamloops to Darfield.

Shuswap (Area B) — South Thompson River east of Kamloops to Shuswap Lake, south half of Adams Lake; Shuswap Lake in the Salmon Arm-Enderby area.

Vernon (Area C) — Vernon-Lavington-Larkin area.

Columbia (Area D) — Columbia River Valley from Canal Flats to Radium; Premier Lake.

History of outbreaks

Populations of western false hemlock looper larvae increased to infestation levels four times in British Columbia between 1947 and 1984 (Fig. 2), at intervals of 6 to 11 years. Infestations lasted for 2 to 4 years within a major drainage before subsiding. Damage intensity varied from visible defoliation[2] only to combined defoliation, top-kill, and tree mortality. Specific sites often were defoliated only for one year within a drainage, although this could still result in tree mortality (Shepherd 1977). For each infestation, the pattern of defoliation and larval populations are described, based only on damage data in 1947 and 1948, and on both damage and larval numbers (the latter calculated for the four major geographic study areas) from 1949 to 1984. From 1952 to 1955, moderate populations also occurred at several locations in the southern interior (peaking at an average of 2 to 13 larvae per sample in 1953 for the 4 study areas), both in dry belt and wet belt sites, but no visible damage was recorded.

The term infestation was applied to areas in which host trees sustained defoliation visible from the ground or air for one or more years. The infestation period was from the first year to last year that visible defoliation occurred anywhere within susceptible stands.

1947-1948

In 1947-1948, an infestation of this looper occurred in the Columbia area between the north end of Columbia Lake and Radium (Fig. 2a). Severe defoliation occurred in scattered patches of Douglas-fir reproduction. In 1948, the main portion of the infestation was sprayed with D.D.T. to prevent damage to Christmas trees. This treatment, together with an unknown disease, caused the infestation to collapse. Limited tree mortality was evident up to 1950.

1962-1963

In 1962, light defoliation occurred in the Shuswap area at McGillivray Lake near Chase and at Agate Bay on Adams Lake, and in 1963, moderate to severe defoliation occurred near Chase on 40 ha (Fig. 2a).

In the Shuswap area (Figs. 2a and 3b), the average numbers of larvae per sample rose slightly to 2 in 1961, and the percentage of positive samples rose to 62%. In 1962, the year that defoliation was first visible in the study area, the average larval count increased to 8 and the percentage of positive samples rose to 80%. In 1964, the average larval count peaked at 37 in the beating samples, but populations collapsed later that year, and no visible damage was recorded. Up to 60% parasitism of eggs, larvae and pupae occurred at Chase. In the other three study areas, the average larval count rose in this period (peak 5 to 18) (Fig. 3), but no visible defoliation was reported, and populations then declined.

1972-1975

In 1972, moderate to severe defoliation of Douglas-fir occurred in the Shuswap area near Salmon Arm, Enderby, Celista, White Lake, and Gleneden (Fig. 2b). Light defoliation occurred between Enderby and Mara Lake. Most affected

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[2] The criteria used by FIDS to classify defoliation from the air were as follows:- **light**: discolored foliage barely visible from the air, some branch tip and upper crown defoliation; **moderate**: pronounced discoloration, noticeably thin foliage, top third of many trees severely defoliated, some completely stripped; **severe**: bare branch tips and completely defoliated tops, most trees more than 50% defoliated.

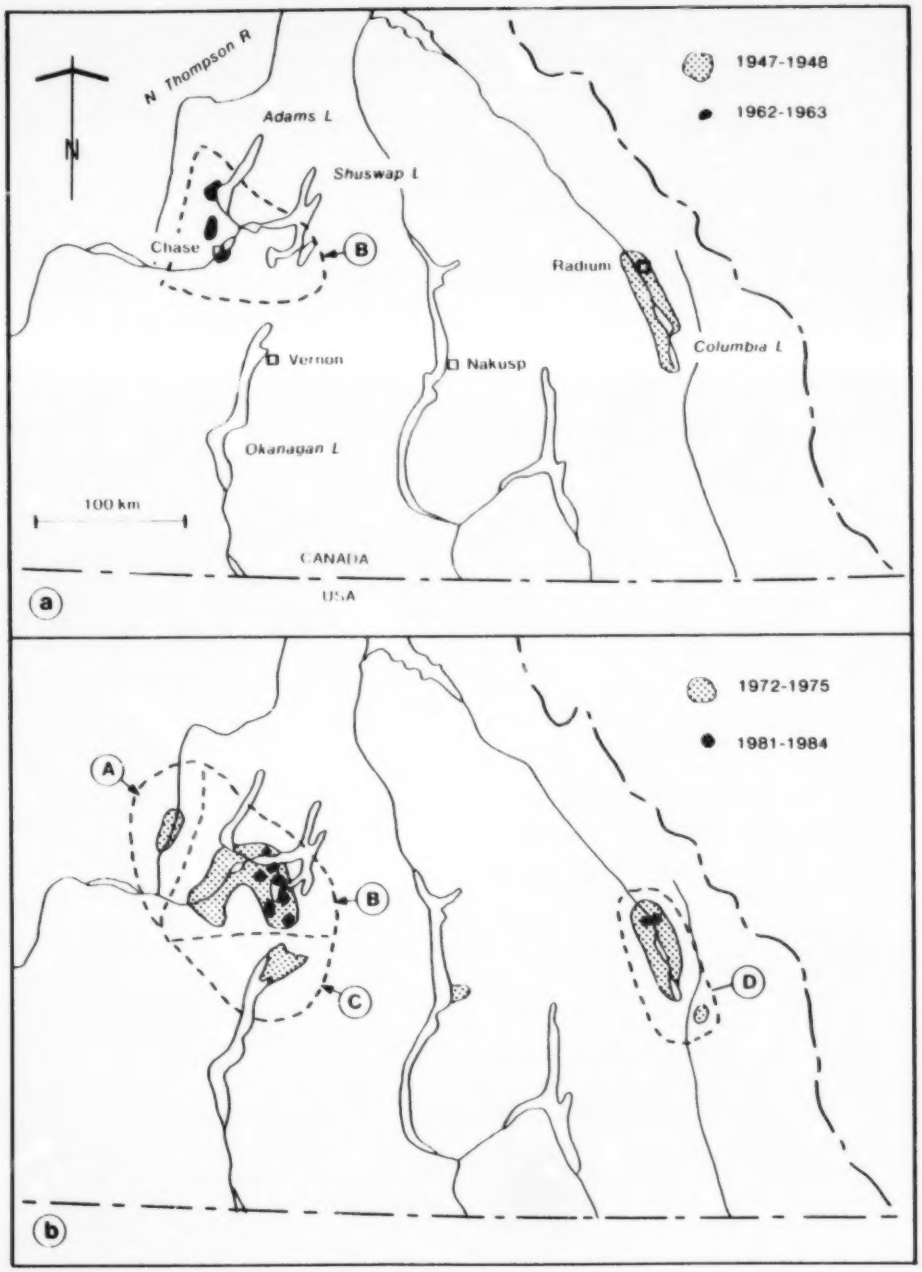

Fig. 2. Infestations of western false hemlock looper in the southern interior of British Columbia, 1947-1984: (A) North Thompson, (B) Shuswap, (C) Vernon, (D) Columbia.

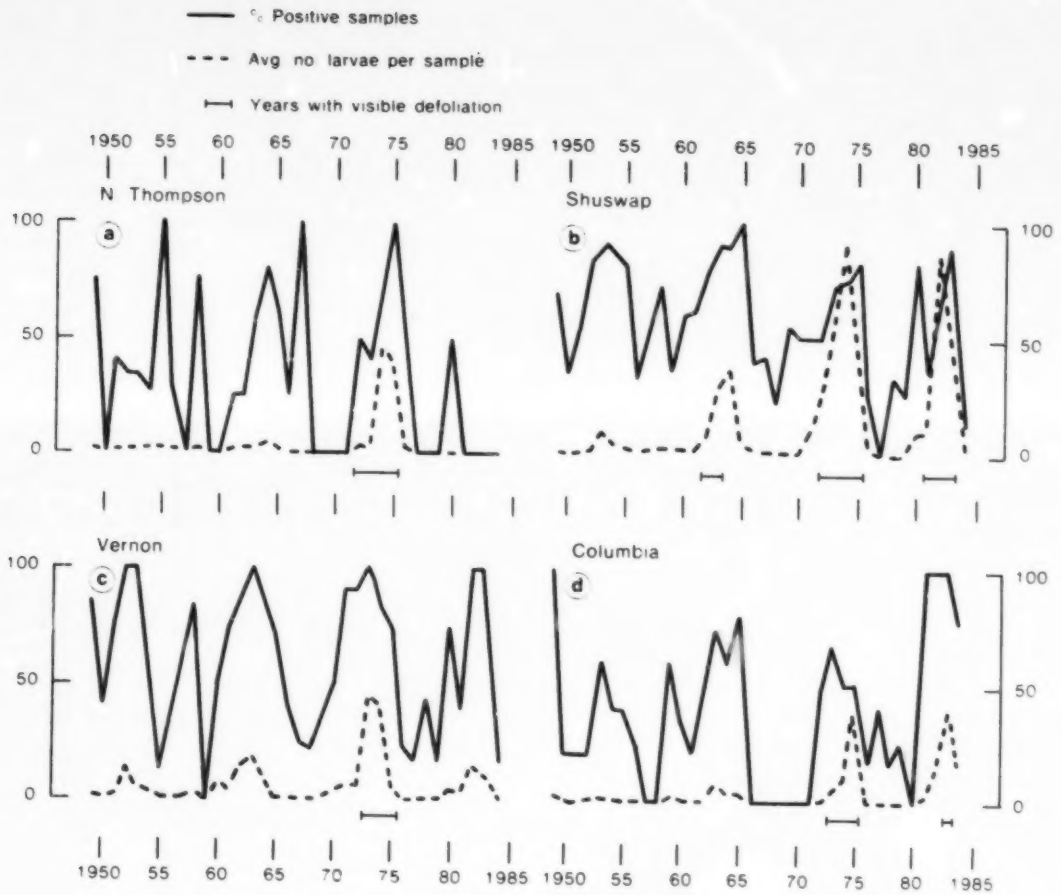

Fig. 3. Average annual western false hemlock looper larval populations on Douglas-fir in southern interior of British Columbia for the four major study areas, 1949-1984.

trees were in pure stands of Douglas-fir often on dry rocky sites. In 1973, populations were reduced near Salmon Arm by some egg parasitism but populations expanded in other locations such as Vinsulla in the North Thompson area, Chase in the Shuswap area, and Lavington in the Vernon area, where new areas of defoliation were recorded. Mortality of trees severely defoliated in 1972 occurred in the Shuswap area at Sunnybrae, Gleneden, and White Lake.

In 1974, considerable expansion of the infestation occurred in the North Thompson River Valley and in the Shuswap Lake drainage at Chase and Little Shuswap Lake, and near Vernon at Lavington. Moderate to severe defoliation was recorded on over 5600 ha. Along the North Thompson River, part of the damage was caused by a combination of feeding of false hemlock looper and Douglas-fir tussock moth larvae, often on the same trees. The infestations continued to decline in the Salmon Arm-Enderby area. Near Sunnybrae and Gleneden, mortality of semi-mature Douglas-fir with 90% or greater defoliation in 1973 and continued defoliation in 1974 occurred on 120 ha. Trees with less defoliation, attacked only in 1973 and not again in 1974, recovered. The infestation declined considerably in 1975, with light to moderate defoliation in the Shuswap area at Monte Lake (300 ha) and from Louis Creek to Barriere (320 ha) along the North Thompson River. Defoliation at Barriere was

caused by the combined feeding of larvae of both false and western hemlock (*Lambdina f. lugubrosa* (Hulst.)) loopers. Small areas of light defoliation occurred near Vernon at Larkin and Lavington, and in the Shuswap area at Pritchard. High parasitism in overwintering eggs appeared to be the main cause for population decline, and populations dropped to low levels in 1976.

In the North Thompson area (Figs. 2b and 3a), there were no larvae in the samples in 1971, the year before visible defoliation. In 1972, the first year of visible defoliation, the average larval count rose to 3 and the percentage of positive samples rose to 50%. The larval count peaked at 47 in 1974, and the percentage of positive samples peaked at 100% in 1975.

In the Shuswap area (Figs. 2b and 3b), the average larval count was 12 in 1971 and the percentage of positive samples was 50%. In 1972, the first year of visible defoliation, the average larval count rose to 31, but the percentage of positive samples was unchanged. The average larval count peaked at 91 in 1974 and the percentage of positive samples peaked at 83% in 1975. In the Vernon area (Figs. 2b and 3c), the average number of larvae rose from 7 in 1972 to a peak of 46 in 1973, the year of first visible defoliation. The percentage of positive samples rose from 91% to 100%.

In 1973, severe defoliation occurred at Nakusp on 10 ha of immature mixed conifers (caused by combined feeding of false and western hemlock loopers), and on individual western hemlock and Douglas-fir. Light defoliation was evident on new growth of regeneration and pole-sized Douglas-fir in the Columbia area from Dutch Creek to Swansea Mountain (Fig. 2b). In 1974, the infestation at Nakusp collapsed, but light defoliation continued in the Columbia area at Windermere Lake and a new localized area at Premier Lake. Moderate defoliation occurred in the Columbia-Windermere lakes area in 1975: 40 ha at Columbia Lake, 6 ha at Dutch Creek, 32 ha at MacCarthy Lakes, 20 ha at Johnson Creek, 10 ha at Stoddart Creek, and 44 ha at Brady Creek. In 1976 the infestation collapsed, apparently because of a virus infection of larvae which appeared in 1975. No tree mortality was evident.

In the Columbia area (Figs. 2b and 3d), the average number of larvae was 1 and the percentage of positive samples was 50% in 1972, the year before visible defoliation. In 1973, the first year of visible defoliation, the average larval count rose to 5 and peaked at 38 in 1975. The percentage of positive samples peaked in 1973 at 67%.

1981-1984

In 1981, light defoliation occurred in the upper crowns of mature Douglas-fir on 350 ha in the Shuswap area at five locations (Fig. 2b). In 1982, the area of defoliation expanded to 1150 ha at 12 locations in the Shuswap Lake area, with most defoliation ranging from moderate to severe. In the Columbia area, larval populations increased noticeably, but no defoliation was recorded. In 1983, defoliation in the Shuswap area decreased considerably to 250 ha of mainly light defoliation. The decline was attributed to a high incidence of naturally occurring biological control factors, the most important of which was a nuclear polyhedrosis virus affecting larvae. Tree mortality occurred on a 25-ha rocky site near Sunnybrae. Near Invermere, in the Columbia area, very light defoliation was recorded on 110 ha. High populations occurred near Revelstoke on western hemlock within stands defoliated by the western hemlock looper. In 1984, populations collapsed in the Shuswap and Columbia areas (both from unknown cases), and no defoliation was recorded from either area, indicating a probable termination of this infestation.

In the Shuswap area (Figs. 2b and 3b), the average larval count rose from 9 in 1980 to 10 in 1982, the first year of visible defoliation. The percentage of positive samples rose from 25% to 83%. The larval count showed a peak of 85 in 1982, and the percentage of positive samples reached 100% in 1983. In the Vernon area (Fig. 3c), larval populations peaked at 15 in 1982, but visible defoliation did not occur in this area. In the Columbia area (Figs. 2b and 3d), the larval count rose from 16 in 1982 to 37 in 1983, the first year of visible defoliation. The percentage of positive samples was 100% in both years.

Discussion

Western false hemlock looper populations periodically increase to outbreak levels, causing localized tree defoliation and mortality, and then

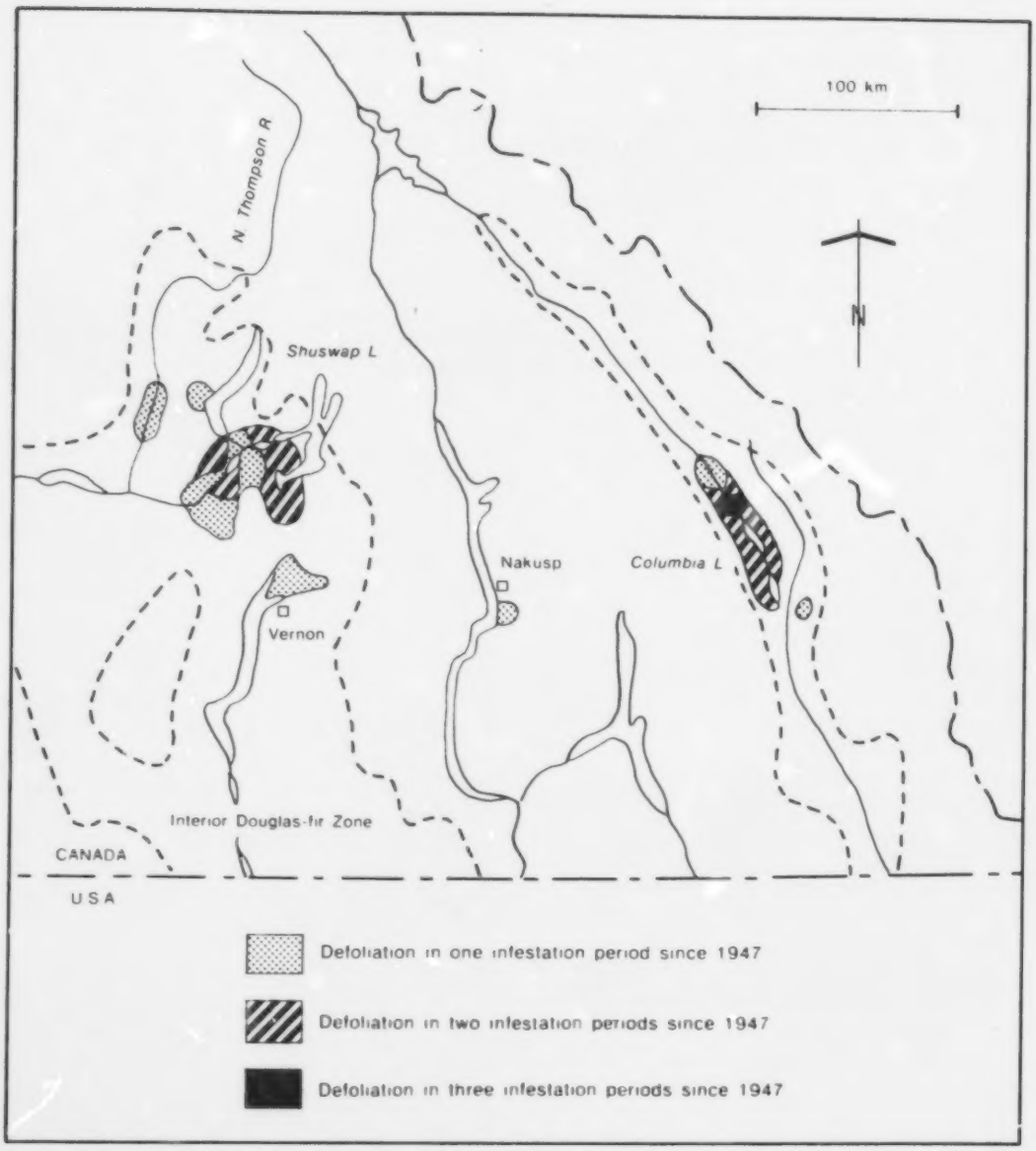

Fig. 4. Locations most likely to have western false hemlock looper infestations in the southern interior of British Columbia.

rapidly decline. Most damage has been confined to the dry subzone of the Interior Douglas-fir Biogeoclimatic Zone (Shepherd 1977) (Fig. 4), but localized damage has occurred at Nakusp in the Interior Cedar-Hemlock Zone.

Sampling in the future should concentrate on locations where high larval populations and visible damage have occurred, especially during more than one infestation (Fig. 4). A rise in the average number of larvae per sample and in the frequency at which larvae occur in samples taken from these areas should alert the observer, causing a closer monitoring of the stands, and possibly an assessment of current economic values and preparation for control action.

Since the start of the 3-tree beating method for monitoring defoliator larvae in 1949, there have been four false hemlock looper infestations in the southern interior of B.C. In the seven instances of population increase examined (increases accompanied by visible defoliation), the average number of looper larvae per sample in the year preceding that with visible defoliation was zero in one instance and between 1 and 16 in the other six instances, and percent positive samples were 0% and between 50% to 100%. In the first year that visible defoliation occurred within a study area, the average larval count rose to between 3 and 46 and peaked a year or two later at 37 to 91. The percentage of positive samples rose to between 50% and 100% and peaked at 67% to 100%. Populations dropped to very low levels one to three years after defoliation was last recorded somewhere in the general area.

In a year when larval populations average 3 or more in a sample and the percentage of positive samples reaches 50% or higher, noticeable defoliation may occur later that year. A decline or collapse of an infestation can be expected if there is a twofold to threefold drop in the percentage of positive samples (to 50% or less) and the average number of larvae per sample drops to 3 or less.

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